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ON NATURAL AND ARTIFICIAL IMMUNITY.

BY O. LOEW, MEMBER OF THE UNIVERSITY OF MUNICH, FORMERLY MEMBER OF THE WHEELER EXPEDITIONS, WEST OF THE 100th MERIDIAN, OF THE U. S. CORPS OF ENGINEERS.

SINCE the beginning of the extensive bacteriological investigations of Pasteur, about twenty years ago, the new-born science of bacteriology has developed to gigantic proportions, and, although this science is still in its youth and capable of an immense extension, it has become of an extraordinary importance and of universal interest. No other science can boast of such rapid development. Many investigators botanists, hygienists, physicians, and chemists, have contributed their share to raise the science to an imposing figure. We name here above all: C. Nägeli, R. Koch, Rudolf Emmerich, Hans Buchner, M. Nencki, the Italians Tittoni and Cattani, the Americans Billings and Dixon, the Japanese Kitasato and Tsuboi, the Englishman Hankin, and the Germans Hüppe, Scholl, and Baumgarten.

It was Koch who invented excellent methods of isolating different bacteria species and made us acquainted with the bacillus of tuberculosis and the comma-bacillus; Kitasato isolated for the first time the bacillus of influenza and of tetanus (lockjaw); Nencki, Krieger, Hüppe, and Scholl isolated poisonous albuminous products of different bacteria species. But it was essentially Professor Rudolf Emmerich of Munich,[1] whose everlasting merit it is to have taken the first successful steps for solving the mystery of natural and artificial immunity.

We know now that nine-tenths of all diseases of man and animals are due to certain bacteria species that either by the lungs or by the stomach enter the body, multiply in the blood, and yield poisonous secretions that finally attack the nervous system and kill the body if no powerful reaction sets in that kills the bacteria, while their poisonous secretions are expelled by the body by oxidation or by the excreta.

Now, this reaction against bacterial evil-doings is the most interesting and marvellous process in the science of bacteriology and medicine, a process that was surrounded by a deep mystery, and the more interesting as it became evident that an animal having passed through a certain infectious disease, had acquired a certain resistance for a certain period against the same cause of disease. Experiments of Pasteur had shown this to be the case in various diseases. This resistance gained by passing through an infectious disease is known by the name of artificial immunity.

There exists, however, also a natural immunity, that is, the resistance of certain animal species against certain kinds of bacteria, without ever having passed through an infectious disease. For instance, rats and dogs are incapable of getting tuberculosis or swine plague (roth lauf), rats are incapable of anthrax, most animals are incapable of typhoid fever and Asiatic cholera.

It was Professor Emmerich who discovered first, in 1886, that the blood of an animal that had recovered from an infectious disease can cure another animal from the same disease or even prevent the development of the same disease if subcutaneous injections are made. He had proved, for the first time, that the bacteria in question are killed rapidly in the blood of an animal that had acquired immunity. He supposed, at that time, that there are formed certain albuminous combinations that act as poisons upon the barteria. Sometime afterwards, H. Buchner proved indeed that the fresh blood of various animals contains albuminous bodies detrimental to bacteria and that the natural immunity is thus easily explained, while for the artificial immunity this was proved later by Emmerich. This was to many a remarkable surprise, for all albuminous substances had been heretofore considered as the best nutrition for every living cell.

But this surprise was not altogether justified, for two Americans, S. Weir Mitchell and Edward Reichert, had demonstrated that the poison of the rattlesnake consists of two albuminous bodies, and a little later such poisonous combinations have been isolated from the seeds of *Abras preratorius* and of *Ricinus communis*. Now, if there existed albuminous bodies noxious for the higher animals and not for bacteria, there could not more be wondered at, if albuminous bodies existed noxious to bacteria and not for animals. There exists, however, a third class of albuminous substances (proteids) noxious to both animals and bacteria.

Here must be mentioned, also, the theory of Metschnikoff in regard to the disappearance of bacteria in the blood of an infected animal. He had observed that the white blood-corpuscles or lymphatic cells devour living bacilli, for instance, the bacteria of anthrax, and he believed, therefore, this to be the principal way to get rid of the entered bacteria. This theory of the phazorytose, however, did not give sufficient explanation in several regards.

The investigations of Professor Rudolf Emmerich have shown us that the albuminous bodies of the serum of dogs' blood, when precipitated by alcohol and redissolved in water containing 0.4 p. mille caustic soda had microbicide properties even then, if by the treatment with alcohol this property had been lost in consequence of a slight chemical change. This proved that a certain atomic constitution can be restituted by the very diluted solution of caustic soda. Not so easily changeable by alcohol is, however, the albuminous body causing the artificial immunity, as Emmerich has found, and while it is easy to cure with blood of artificially immunized animals, no one was able until now to observe a cure by application of blood of naturally immune animals. One cannot immunize, for instance, with dog's blood against tuberculosis of man or with the blood of rabbits against typhoid fever.

Professor Emmerich and Professor Tsuboi have investigated the blood of rabbits that were artificially immunized against swine-plague (roth lauf). The serum of this blood was (after separation of the globulin) concentrated at 42° C. in vacuo, whereby an albuminous body of prominent curing properties was precipitated. The filtered liquid, however, gave upon precipitation with alcohol also a substance of the same curing qualities. This substance was washed with alcohol and ether and dried at a low temperature. This dry powder possessed all the curing properties of the blood itself against swine-plague. Thus we have for the first time the curing substance (Heilsubstanz) in a dry state, although mixed yet with inactive albuminous substance. This is a fact of immense importance, the most important discovery in bacteriology relating to medicine. Emmerich and Tsuboi gave also a plausible theory in regard to the formation and the mode of action of this remarkable substance, as may be studied in their publication, "Die Natur der Schutz und Heilsubstanz des Blutes," Wiesbaden, 1892. We hope to communicate later more of the investigations of Emmerich and Tsuboi.

A few additional remarks may be permitted to the writer. The great admirable transatlantic republic, with its unrivalled wonderful development, with its immense natural resources, and an unheard of liberality and magnanimity and generosity of

[1] Professor Emmerich is the most successful student of the far-famed hygienist, Professor Dr. Max v. Pettenkofer of Munich.